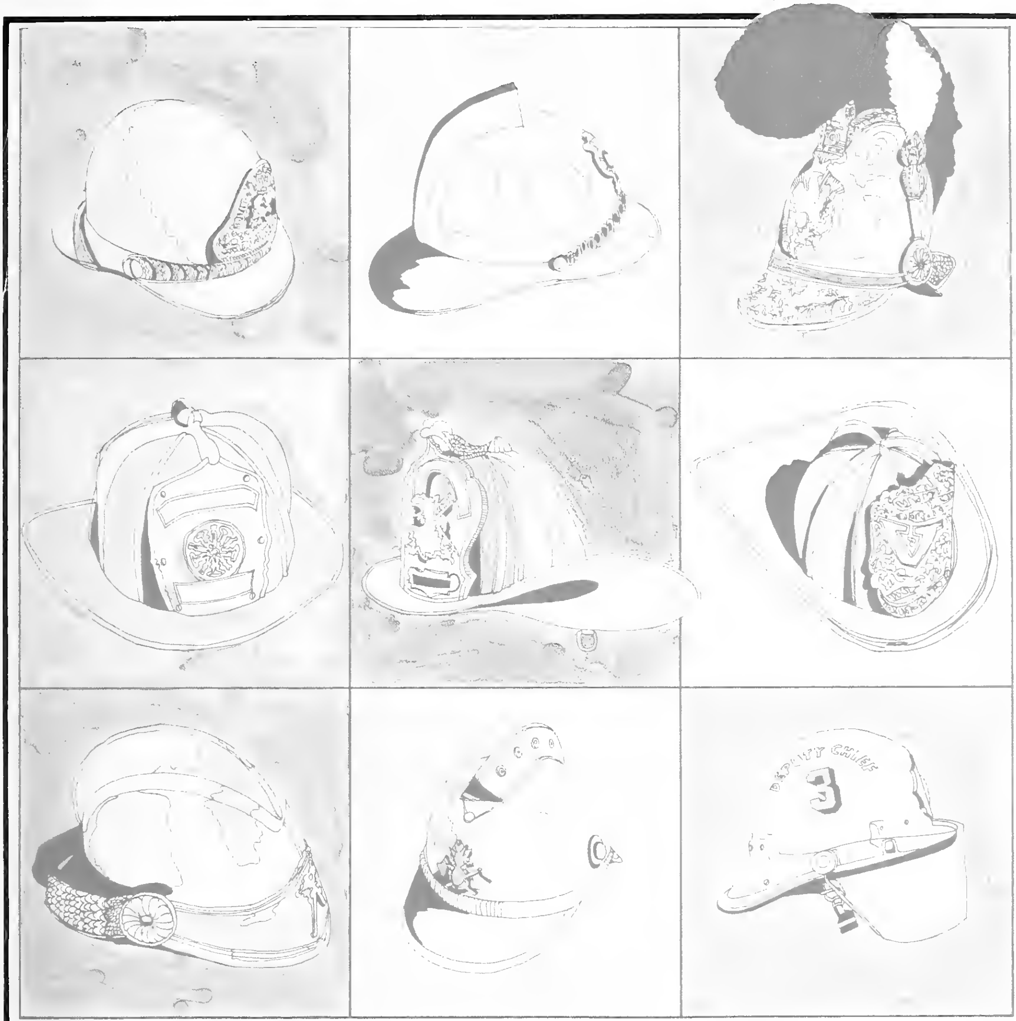


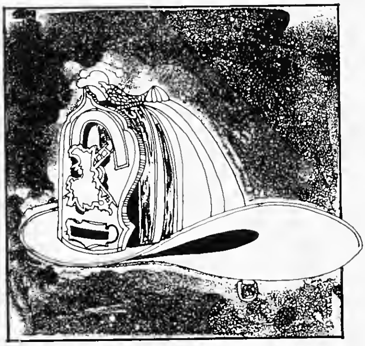
U.S. DEPARTMENT OF COMMERCE

NATIONAL FIRE PREVENTION & CONTROL ADMINISTRATION

National Fire Safety and Research Office

August 1977
Washington, D.C. 20230

MODEL PERFORMANCE CRITERIA FOR STRUCTURAL FIREFIGHTERS' HELMETS



MODEL PERFORMANCE CRITERIA FOR STRUCTURAL FIREFIGHTERS' HELMETS

Prepared by:

National Fire Safety and Research Office,
National Fire Prevention and Control Administration
U.S. Department of Commerce
Washington, D.C. 20230

Based on Research Conducted by:
Institute for Applied Technology
National Bureau of Standards
U.S. Department of Commerce
Washington, D.C. 20234

August 1977

Foreword

Firefighting continues to be the Nation's most hazardous occupation. This report provides new information useful for improving one important part of a firefighters' protection, his helmet.

Ultimately, a total protective system must be provided so that the firefighters' task will be effective, efficient and safe. Our Fire Services Technology program has this objective.

Howard D. Tipton
Administrator

Table of Contents

Model Performance Criteria for Structural Firefighters' Helmets

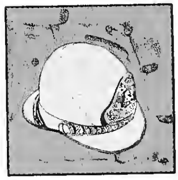
Introduction

The model performance criteria described in this document are intended to be used as the basis for developing and providing improved firefighters' helmets, particularly those used by fire departments that spend a significant amount of time fighting structural fires. Departments responsible for specialized firefighting functions including wildland and aircraft fires should use protective equipment specifically designed for those activities. Certain design features are specified which include ear flaps, chin strap retention, configuration and labeling requirements. Provisions for face shields and other ancillary equipment are not part of the model requirements.

The research effort leading to the preparation of this document was conducted to present a set of performance requirements and associated test methods from which a standard specifically designed for structural firefighters helmets could be written.

A supporting report titled: "Considerations in Establishing Performance Criteria for Structural Firefighters' Helmets" has been prepared to provide the background for this document and can be obtained by contacting the National Bureau of Standards, Department of Commerce, Washington, D.C. 20234.

1. Model Performance Requirements



1.1 Impact Attenuation

When tested in accordance with paragraph 2.1, all helmets tested shall meet the requirements below:

Impact Location	Maximum Acceleration (m/sec/sec)
Top	150 x g_n *(1471.5 m/sec/sec)
Front	400 x g_n *(3924.0 m/sec/sec)
Side	400 x g_n *(3924.0 m/sec/sec)
Back	400 x g_n *(3924.0 m/sec/sec)

Accelerations above 200 g_n shall not exceed three milliseconds in duration; accelerations above 150 g_n shall not exceed five milliseconds.

1.2 Penetration Resistance

There shall be no demonstrable electrical contact between the penetration test striker and the headform when the helmet is tested for penetration resistance as described in paragraph 2.2.

1.3 Chin Strap/Retention System

The static strength of the chin strap/retention system shall be tested in accordance with paragraph 2.3 without any break occurring and

*g_n denotes gravitational acceleration which is defined as 9.80665 meters per second. (See Appendix)

without any resulting slip or stretch of more than 25 mm (1.0 in). The width of the chin strap shall be at least 12 mm (1/2 in).

1.4 Ear Flaps

Ear flaps shall extend at least 25 mm (1 in) in front of the coronal plane and at least 60 mm (2.4 in) below the basic plane (see figure 2).

Ear flaps shall resist ignition when tested in accordance with paragraph 2.4.

1.5 Configuration

The helmet shall be designed to divert falling liquids away from the face and neck.

The helmet shall have no slits, holes or other openings above the reference plane (see figure 2). No part of the helmet shall extend more than 15 cm (5.9 in) from the mid-sagittal plane (see figure 1) nor more than 20 cm (7.9 in) from the coronal plane (see figure 2). Distances are measured perpendicular to the planes.

1.6 Flame Resistance

Helmet shells shall resist ignition when tested in accordance with paragraph 2.4.

1.7 Heat Resistance

When tested in accordance with paragraph 2.5:

a) there shall be no visible distortion of the helmet suspension/retention system, chin strap, or ear flaps

b) no part of the helmet shell shall touch the headform

c) any shell distortion in the back of the headform shall not extend more than 8 cm (3.1 in) below the *basic* plane, and

d) any shell distortion in the front and sides of the headform shall not extend more than 4 cm (1.6 in) below the *reference* plane.

1.8 Electrical Insulation

Electrical leakage shall not exceed 3 milliamperes when the helmet is tested as described in paragraph 2.6.

1.9 Visibility and Reflectivity

1. For maximum visibility the helmet should be of minimum lightness in color such as white, yellow, light orange, light red, etc. For this document maximum visibility is designated as Munsell Value 7/(43.06%) for CIE source "C" (6774K) or lighter when tested in accordance with "Standard Method of Specifying Color by the Munsell System" or ASTM E308-66, "Standard Recommended Practice for Spectro-photometry and Description of Color in CIE 1931 System."

2. The helmet shall have retro-reflective markings on each of four locations: front, back, right side and left side. The area covered in each location shall be at least 40 cm^2 (6.2 in^2). When tested as described in paragraph 2.7, the retro-reflective material shall meet the requirements given in the table below:

Minimum Candlepower per Foot Candle per sq. Ft.

Observation Angle (degrees)	Entrance Angle (degrees)		
	−4	+30	+50
0.2	70	30	3.5
0.5	30	15	3.0

2. Associated Test Methods

2.1 Impact Attenuation Test

Four helmets (for large purchases, suitable quality control procedures and sampling plans should be arranged. Mil Std. 105 "Sampling Procedures and Tables for Inspection by Attributes" is recommended as a guide) are required for the environmental conditioning as described in paragraph 2.1.2. A schematic diagram of an impact attenuation test set-up is shown in figure 3.

2.1.1 TEST EQUIPMENT

2.1.1.1 Test Headform

The test headform, which is size 7 1/4, shall conform to the dimensions in figures 2 and 4. It shall exhibit no resonance frequencies below 3000 Hz; it may be made of any low resonance magnesium alloy such as magnesium K-1A.

2.1.1.2 Drop Assembly

The drop assembly consists of the test headform, the accelerometer, and the supporting crossarm assembly and shall have a total mass of 5.2 ± 0.2 kg (11.4 ± 0.4 lb). The center of mass of the assembly shall lie within a cone of 10 degrees included angle about the vertical, with apex at the point of impact.

2.1.1.3 Test Anvil

The test anvil shall be steel and have a flat striking surface. The anvil shall be firmly mounted on a steel plate 250 X 250 X 25 mm (10 X 10 X 1 in) minimum, backed with a solid mass of at least 140 kg (309 lb).

2.1.1.4 Acceleration Measurement System

An accelerometer is used to measure the acceleration imparted to the helmeted headform upon striking the anvil and should be able to withstand shocks up to $2000g_n$. The acceleration data channel, including all instrumentation which may alter the frequency content of the test data and all recording and analysis procedures, shall

comply with SAE Recommended Practice J211b requirements for channel class 1000. The time duration of acceleration shall be measured to within ± 0.1 millisecond.

2.1.1.5 Reference Anvil

The reference anvil is substituted for the test anvil to check the acceleration measurement system. When the bare headform is dropped from an appropriate height, it shall produce a peak acceleration of $400\ g_n \pm 20\ g_n$ and acceleration above 200 g_n of at least one millisecond duration. The reference anvil may be of any material which will reproducibly yield these results. A reference anvil found to be suitable is a one-inch Open Blue Modular Elastomer Programmer available from MTS Systems Corp., P.O. Box 24012, Minneapolis, Minn. 55424.

2.1.2 CONDITIONING FOR TESTING

2.1.2.1 Room Temperature

Condition one helmet at a temperature of 20 − 28°C (68 − 82°F) for at least 4 hours. Test as in paragraph 2.1.3.

2.1.2.2 Radiant Heat

Condition a second helmet by exposing the helmet area to be impacted to an infra-red lamp. The area to be impacted is defined as the circle with 6 cm (2 3/8 in) radius with its center at the impact point of the helmet. Mount the helmet on the test headform in the appropriate drop position and raise the drop assembly to the prescribed drop height. Measure the radiant flux by temporarily removing the helmet from the headform and placing a radiometer in the impact area. Adjust the distance of the heat source until a constant radiant flux of 0.6 watts per square centimeter is achieved. Remove the radiometer and reposition the helmet on the headform and subject the impact area to the radiant flux for three minutes.

The heat source should be mounted so that it can be easily swung away to allow helmet impact immediately after the application of heat. Test according to paragraph 2.1.3. If the helmet is not impacted within 10 seconds after removal of the heat source, reapply the heat load for an additional 3 minutes.

2.1.2.3 Water

Condition a third helmet by immersing it in water at a temperature of 25 ± 5°C (77 ± 9°F) for not less than 4 hours nor more than 24 hours. Test according to paragraph 2.1.3 within 10 minutes after removal from the water.

2.1.2.4 Low Temperature

Condition a fourth helmet by exposing it to a temperature of −15 + 0 −°2 C (5 + 0 −4°F) for not less than 4 hours. Test according to paragraph 2.1.3. If the test is not completed within one minute after removal from the cold temperature environment, recondition the helmet 10 minutes for each minute out of the chamber.

2.1.3 TEST PROCEDURE

Mount the accelerometer at the center of mass of the drop assembly with the sensitive axis aligned to within 5 degrees of the true vertical when the headform is in the impact position.

Prior to testing, allow all electronic equipment to warm up for 30 minutes or until stability is achieved. Throughout calibration and testing, the ambient temperature shall be 20 to 28°C (68 to 82°F) and the relative humidity 30 to 70 percent.

Check all instrumentation before and after each continuous sequence of tests by impacting the bare instrumented headform on the reference anvil. Record a minimum of three such impacts before and after a test sequence and make them part of the test record. Should the acceleration-time history not meet the required tolerance (2.1.1.5) prior to testing, adjust the equipment as necessary. Should the post-test average differ from the pretest average by more than 40 g_n, discard the entire test series.

Position the helmet squarely on the headform and secure it to the headform-crossarm assembly by its chin strap or other means which will not interfere with the test, so as to maintain this position during guided fall.

Adjust the drop height so that the velocity at impact is 6.0 ± 0.2 meters per second (19.6 ± 0.7 ft/sec.)

Impact each helmet once at each of the four sites described below:

Drop Site	Impact Area
Top	No more than 75 mm (3 in) from the point described by the intersection of the helmet shell, the mid-sagittal plane and the coronal plane (see fig. 2).
Side	No more than 75 mm (3 in) from the line described by the intersection of the coronal plane and the helmet surface, above the reference plane and below the top impact area.
Front	At least 25 mm (1.0 in) above the reference plane, below the top impact area and in front of the side impact area.
Back	Above the reference plane, below the top impact area and to the rear of the side impact area.

The mass of the test helmet is not included in calculating the impact energy.

2.2 Penetration Resistance Test

Two of the helmets used in the impact attenuation test may be used for this test. A diagram of the penetration resistance test set-up is shown in figure 5.

2.2.1 TEST EQUIPMENT

2.2.1.1 Test Headform

The test headform, which is size 7 1/4, shall conform to the dimension in figures 2 and 4. Above the reference plane, it shall have an electrically conductive surface which is electrically connected to the contact indicator (2.2.1.3).

2.2.1.2 Penetration Striker

The penetration striker shall have a mass of 1.0 kg + 25 g −0.0 g (2.2 lb + 0.05 lb − 0.0 lb). The point of the striker shall be a cone with an included angle of 60 ± 0.5 degrees, a height of 38 mm (1.5 in) and a tip radius of 0.5 ± 0.1 mm (0.020 ± 0.004 in). The hardness of the striking tip shall be Rockwell scale-C 60, minimum. The penetration striker shall be electrically connected to the contact indicator (2.2.1.3).

2.2.1.3 Contact Indicator

The contact indicator shall indicate when electrical contact of 1 millisecond duration or longer has been made between the penetration striker and the conductive surface of the test headform.

2.2.2 CONDITIONING FOR TESTING

2.2.2.1 Room Temperature

Condition one helmet at a temperature of 20 to 28°C (68 to 82°F) for at least 4 hours.

2.2.2.2 High Temperature

Condition one helmet in a circulating air oven controlled at 100 ± 3°C (212 ± 50°F) for not less than 4 hours nor more than 24 hours.

2.2.3 TEST PROCEDURE

Place the conditioned, complete helmet on the rigidly mounted test headform and secure it by its chin strap or by other means which will not interfere with the test. Adjust the helmet in the same manner as a person would adjust it to his head. Drop the penetration striker in guided free fall onto the outer surface of the helmet anywhere above the reference plane and at least 75 mm (3.0

in) from the center of a previous impact site or penetration site. Drop the striker from a height of 2.50 + 0.01−0 meters (98.5 + 0.4−0 in) as measured from the striker point to the point of impact on the outer surface of the helmet. Apply a minimum of two penetration blows at different locations to each of the two helmets. The long axis of the striker should be perpendicular to the plane tangent to the impact area. If the test is not completed within 3 minutes after high temperature conditioning, recondition and repeat.

2.3 Chin Strap/Retention System Test

The same test helmets used in the impact attenuation test may be used for this test. A diagram of the test set-up is shown in figure 6.

2.3.1 TEST HEADFORM

The test headform shall be size 7 1/4 and capable of supporting the helmet when a load of 890 newtons (200 pounds force) is applied to the retention system.

2.3.2 CONDITIONING FOR TESTING

2.3.2.1 Room Temperature

Condition one helmet at a temperature of 20 to 28°C (68 to 82°F) for at least 4 hours.

2.3.2.2 High Temperature

Condition a second helmet by exposing it in a circulating air oven to a temperature of 100 + 3°C (212 + 5°F) for not less than 1 hour nor more than 3 hours.

2.3.3 TEST PROCEDURE

Place the conditioned, complete helmet on the rigidly mounted test headform and fasten the chin strap to the loading device, as shown in figure 6. Adjust the helmet on the headform so that the points of attachment of the chin strap to the helmet will be subjected to the same stress as the chin strap. Support the helmet so that it will not move during the application of the test loads.

Apply the test loads perpendicular to the basic plane of the headform and symmetrically with respect to the helmet retention system.

Statically load the chin strap system with 100 newtons (22 pounds force) for at least 30 seconds but no more than 1 minute and then measure the maximum distance between the chin strap and the apex of the helmet. Do not remove the load.

Apply an additional 550 newtons (124 pounds force) for at least 3 minutes and again measure the maximum distance between the chin strap and the apex of the helmet.

Record any break in the chin strap/retention system. Record any slip or stretch as the difference between the two distance measurements. If the test is not completed within 5 minutes after high temperature conditioning, recondition and repeat.

2.4 Flame Resistance Test

2.4.1 SHELL

Place the helmet on an epoxy headform in front of a radiant heat source such as the type described in ASTM E162 so that the basic plane of the head form is parallel to the radiant heat source. Position the helmet so that the crown receives a radiant flux of 0.6 w/cm^2. After 60 seconds exposure to the radiant flux, and without removing the helmet from the heat source, place the cone tip of a methane flame against the helmet crown so that the cone makes an angle of 45° with the plane tangent to the crown (see figure 7). After 15 seconds remove the flame and observe whether the helmet shell resists ignition. (No visible flame or

afterglow 5 seconds after removal of methane flame.). If part of the shell is constructed of a different material than the crown, test each material in an equivalent manner.

2.4.2 EAR FLAPS

The flame resistance test for ear flaps is the same as 2.4.1 with the following exceptions:

1. The mid-sagittal plane of the helmet is parallel to the heat source.
2. The ear flap receives a radiant heat flux of 0.6 w/cm^2.
3. The cone of the flame is applied at an angle of 45° with the ear flap.

2.5 Heat Resistance Test

Mount the helmet with ear flaps down on an epoxy headform conforming to the dimensions in figures 2 and 4, and fasten the chin strap securely. Place the headform, with helmet attached, into a circulating air oven which has been preheated to 250 ± 3°C (482 ± 5°F). After three minutes remove the helmet and headform and measure the shell distortion, relative to the basic and reference planes, at the front, sides and back of the helmet. Then remove the helmet from the headform and examine the chin strap, ear flaps, and retention system for distortion.

2.6 Electrical Insulation Test

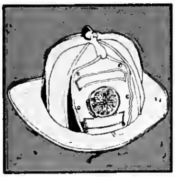
Support the helmet in an inverted position with a wire frame and place it in a vessel containing tap water. Submerge the helmet until the water is within 13 mm (1/2 in) of the reference plane. Fill the inside of the helmet to within 13 mm (1/2 in) of the reference plane with tap water. Attach one terminal of a suitable transformer to the wire frame.[1] The second terminal is connected to an electrode and immersed in the water in the helmet. Apply a 60 Hz, alternating current voltage and increase it to 2,200 volts root mean square. Maintain the voltage at 2,200 ± 2% for 3 minutes (see figure 8). Caution should be exercised in conducting this test because of the high voltages required.

2.7 Visibility Test—Reflectivity

The retro-reflective material shall be tested in accordance with Federal Specification LS-300B paragraph 4.3.7 (Available from: Federal Supply Services, General Services Administration, Washington, D. C. 20407)

[1]The transformer should have an output voltage which is essentially sinusoidal with a crest factor of 1.41 ± 0.07 (crest factor = peak voltage/true rms voltage).

3. Glossary of Terms



3.1 Basic Plane

The plane through the centers of the external ear openings and the lower edges of the eye sockets (see figure 1).

3.2 Coronal Plane

The plane, perpendicular to the basic and mid-sagittal planes, which passes through the centers of the external ear openings as modeled on a headform (see figures 1 and 2).

3.3 Edging

The edge, rim, or rim trim around a helmet.

3.4 Headform

A test device which conforms to the configuration of the human head (see figures 2 and 4).

3.5 Mid-Sagittal Plane

The plane, perpendicular to the basic and coronal planes, which symmetrically bisects the head (see figure 1).

3.6 Reference Plane

The plane 60 ± 1 mm (2.36 ± 0.04 in)[2] above and parallel to the basic plane.

3.7 Retention System

The complete assembly by which the helmet is retained in position on the head.

3.8 Retro-Reflective Material

A material which reflects and returns a relatively high proportion of light in a direction close to the direction from which it came.

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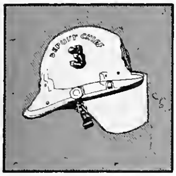
[2]Measures in parentheses are approximate.

4. Model Product Labeling



Each helmet shall be durably and legibly labelled in a manner such that the label can be easily read without removing padding or any other permanent part. The label shall be affixed so that it is not easily removable and shall retain its integrity throughout the Associated Test Methods (Section 2). Each label shall include the following information:

(a) name or designation of manufacturer

(b) model designation

(c) size and weight[3]

(d) month and year of manufacture (uncoded)

(e) lot number

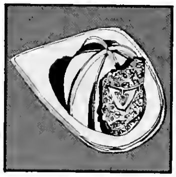
(f) recommended cleaning agents, paints, etc., which can be applied to the helmet without damage

(g) helmets which can be damaged by cleaning with common solvents shall include a warning that some common solvents may damage the shell

(h) helmets with compressible linings shall include a warning that after a severe blow the helmet may no longer protect the head and should be replaced or repaired by the manufacturer.

[3]Weight refers to the helmet, without accessories, as offered for sale.

5. Appendix



Considering the lack of information on *in vivo* human tolerance to head impacts, the variations in impact tolerance from person to person and between impact sites on the head, and that metal headforms used in the testing do not duplicate the response of the human head, it is obvious that the test methods in current use do not measure the actual protection provided by a helmet but rather the ability of a helmet to absorb the energy of a given impact. As test headforms become more realistic and more is learned about the tolerance of human heads to impacts, test methods will improve to the point where they actually measure the amount of protection that a helmet affords in a given situation. In this country, there are basically two methods of testing protective headgear: the falling headform/rigid anvil method described in ANSI Z90.1, and the falling ball/rigid headform method described in ANSI Z89.1

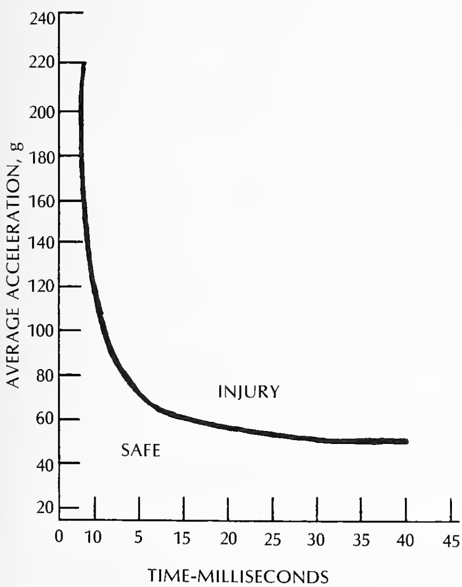
Impact Attenuation

The Z90 method requires impact tests to be conducted on all areas of the helmet top, front, sides and back; the Z89 method requires impact tests only in a small area on the top of the helmet. Although most of the impacts to firefighters may result from debris falling on the top of the head, it cannot be ignored that there is a danger of severe impacts to other parts of the head. Consider, for example, a firefighter crawling on a floor with his head down. It is very likely that falling objects will impact the back of his head rather than the top. There have been several reported cases of firefighters being struck on the sides of the head by errant hose nozzles. Clearly then, to be acceptable, a test method must be able to test all areas of a helmet for its ability to reduce the effects of impacts.

This was an important consideration for selecting a method modeled on Z90 rather than Z89 to test fire helmets.

With the type of data obtained from the method described in Z90, there are several choices of pass/fail criteria: peak acceleration, severity index or head injury criteria. The peak acceleration described in Z90 is simply the maximum acceleration of the headform during impact. This is usually expressed in G's, the dimensionless ratio of the headform acceleration to the acceleration due to gravity (G = headform acceleration (m/sec^2) 9.81 m/sec^2).

A Severity Index is derived from the Wayne State University tolerance curve which shows that head injury is a function of time as well as acceleration. This is shown graphically in the Wayne State University Tolerance Curve below.



The Head Injury Criterion may be considered a refinement of the Severity Index. Both the Severity Index and Head Injury Criterion attempt to make maximum use of biomechanical information provided by the Wayne State University tolerance curve. Some standards such as DOT 218 and the ANSI Z90 acknowledge the existence of the Wayne State University curve by including time limits as well as maximum accelerations in their acceptance criteria. Such considerations are included in the model performance criteria.

The impact requirements in this document are based on test data obtained from various types of helmets and an assessment of the state-of-the-art in materials and helmet design. Helmets which meet the proposed requirements will substantially reduce the effects of blows to the head. In 1976, there were no fire helmets on the market that met these impact requirements (until now, all fire helmets have been patterned either after motorcycle helmets fully lined with an energy absorbing material or industrial hard hats with sling suspension systems). The current state-of-the-art in helmet design and manufacturing can be employed to produce fire helmets that provide better protection than either of the above designs. Moreover, the increased protection can be provided without an appreciable increase in cost and without sacrificing comfort. The requirements in the model standard are based on this assumption.

Penetration Resistance

The penetration resistance test was developed by testing fire helmets with a penetrator similar to the one described in ANSI Z90. Leather, glass reinforced plastic, and polycarbonate all have performed well in providing protection against penetration by sharp objects. For this reason, the requirements were set to prevent any lowering of present performance.

Heat Resistance

A frequently heard complaint about present helmets was low resistance to heat. To substantiate complaints, many deformed helmets and photographs of heat damaged helmets were presented by fire departments in different geographical locations. Using published reports, damaged helmets, photographs, discussions with users and laboratory test results as guides, the proposed thermal requirement was established as a reasonable test condition for high temperature performance. Under these conditions it is possible to duplicate damage to helmets that has occurred in actual use.

Flammability

These criteria require that the helmet and ear protectors be exposed to a direct flame and a high radiant heat load to insure that the protective headgear does not itself become a hazard if the wearer is exposed to an unusually hostile fireground situation. Several of the materials currently used for the fabrication of outer shells were tested and found to meet the proposed criteria.

Chin Straps

This requirement was proposed to prevent helmets from being dislodged during moderate impacts. Although chin straps can be made to withstand much greater loads, users expressed concern that neck injuries might result from unyielding chin straps. These criteria allow manufacturers to design chin straps that will break loose to avoid neck injury.

Electrical Resistance

The requirement for electrical resistance is similar to ANSI Z89.1. Fire helmets that have met this requirement in the past have also performed satisfactorily in actual field use.

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3. Surface Flammability of Materials Using a Radiant Energy Source, ASTM E162, American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.
4. Standard for Motorcycle Helmets, FMVSS No. 218, National Highway Traffic Safety Administration, 400 Seventh Street, S.W., Washington, D.C.
5. Standard for Riot Helmets, NILECJ STD 0104.00, Department of Justice Law Enforcement Assistance Administration, 633 Indiana Avenue, N.W., Washington, D C
6. D. L. Simms and P. L. Hinkley, "Protective Clothing Against Flames and Heat," British Information Services, 45 Rockefeller Plaza, New York, New York.
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8. Development of Criteria for Industrial and Firefighters' Head Protective Devices. HEW Publication No. (NIOSH) 75-125, January 1975.

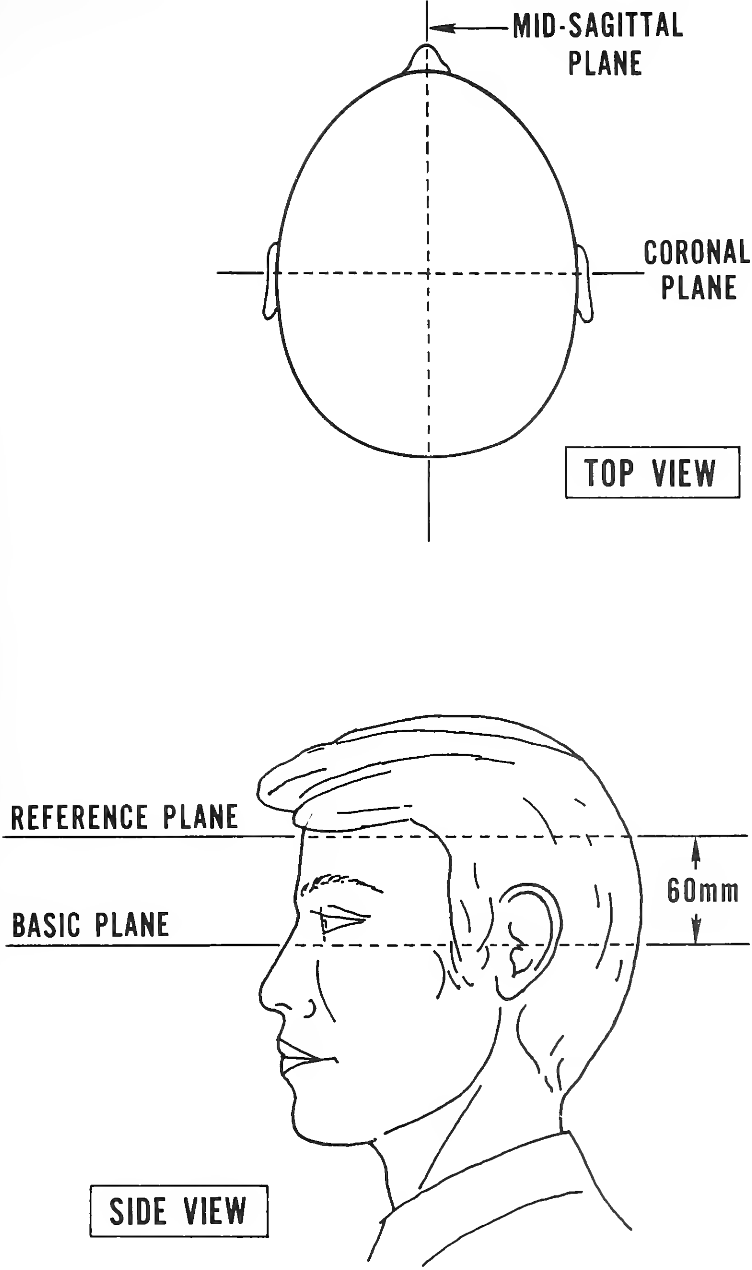


Figure 1. Locations of basic, coronal, mid-sagittal and reference planes.

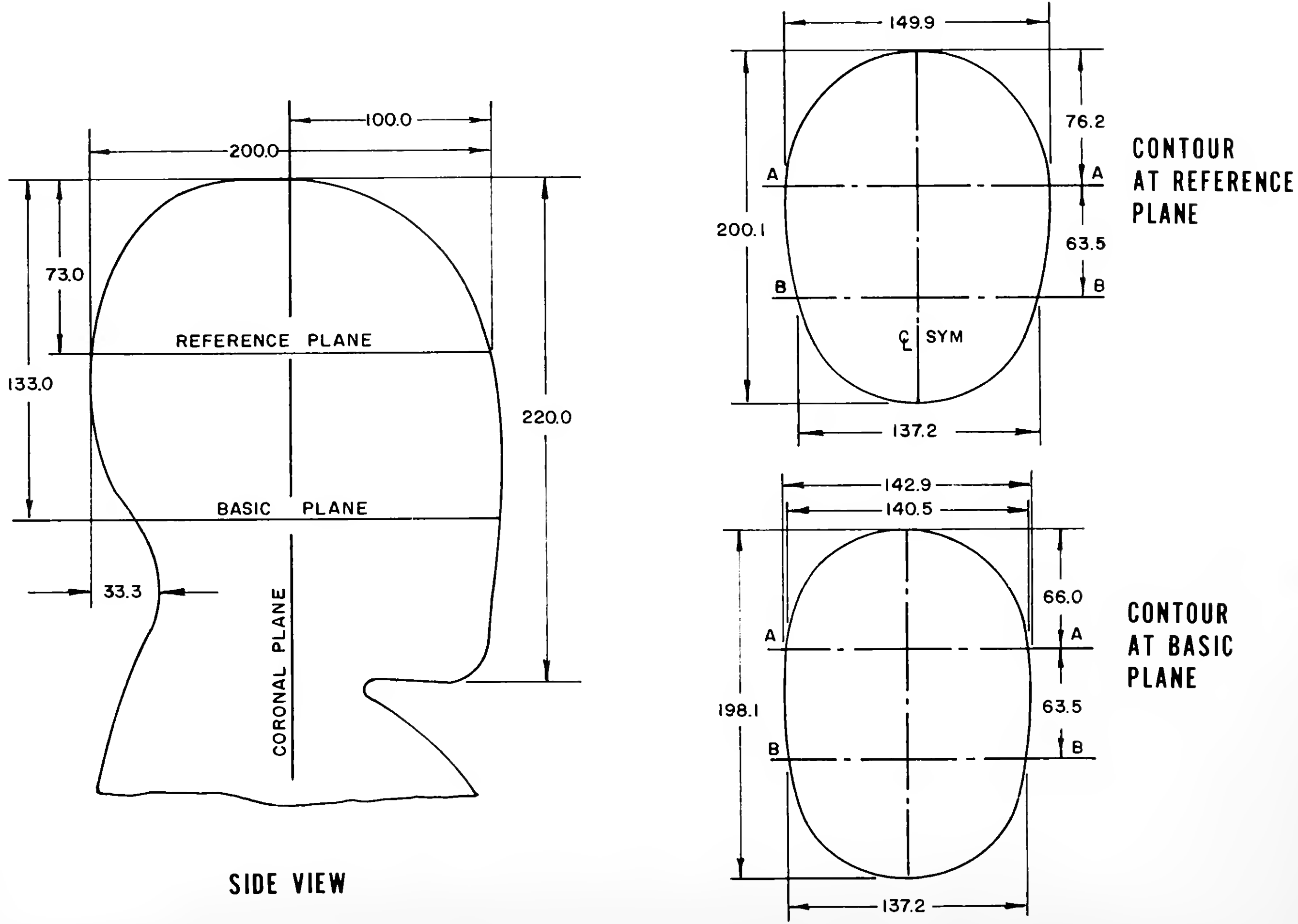


Figure 2. Headform, heat resistance test, dimensions in mm

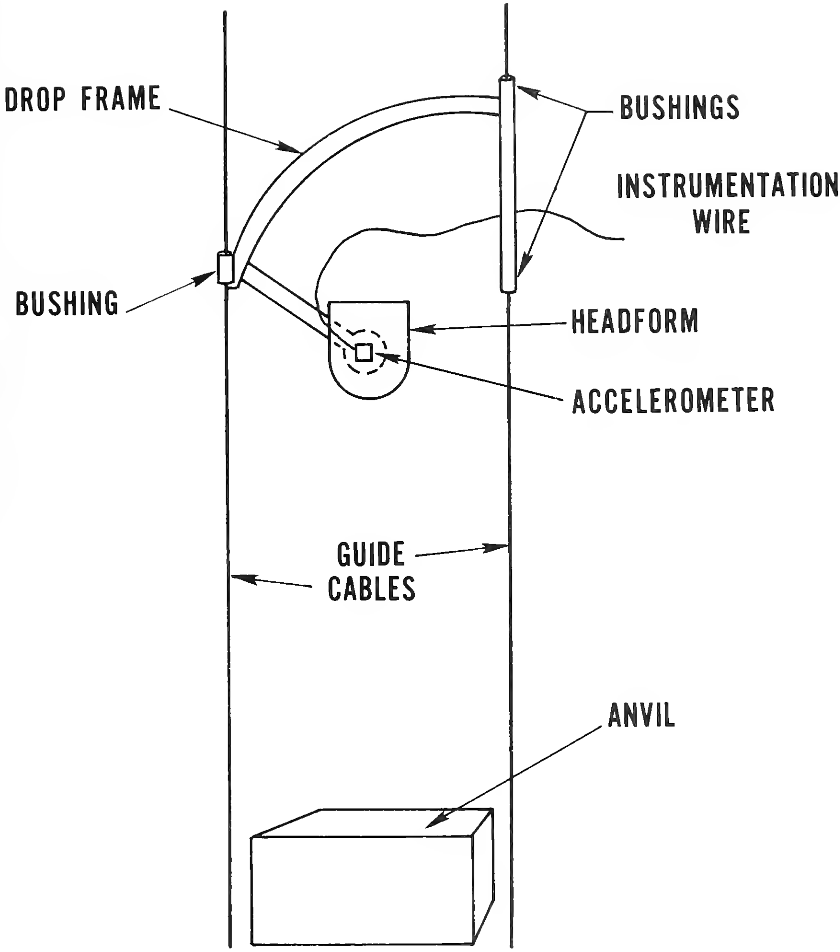
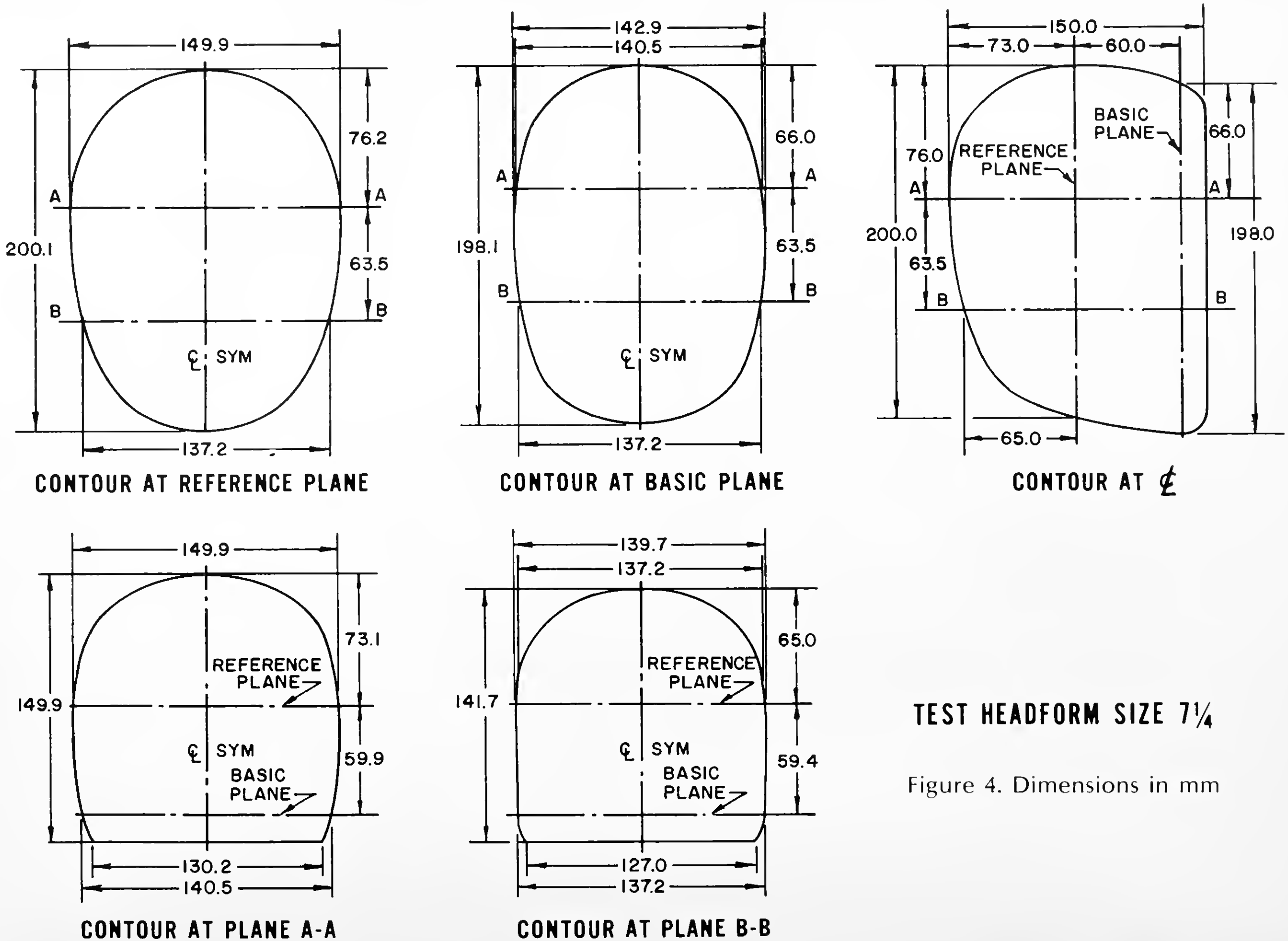


Figure 3. Impact attenuation test setup.



TEST HEADFORM SIZE 7¼

Figure 4. Dimensions in mm

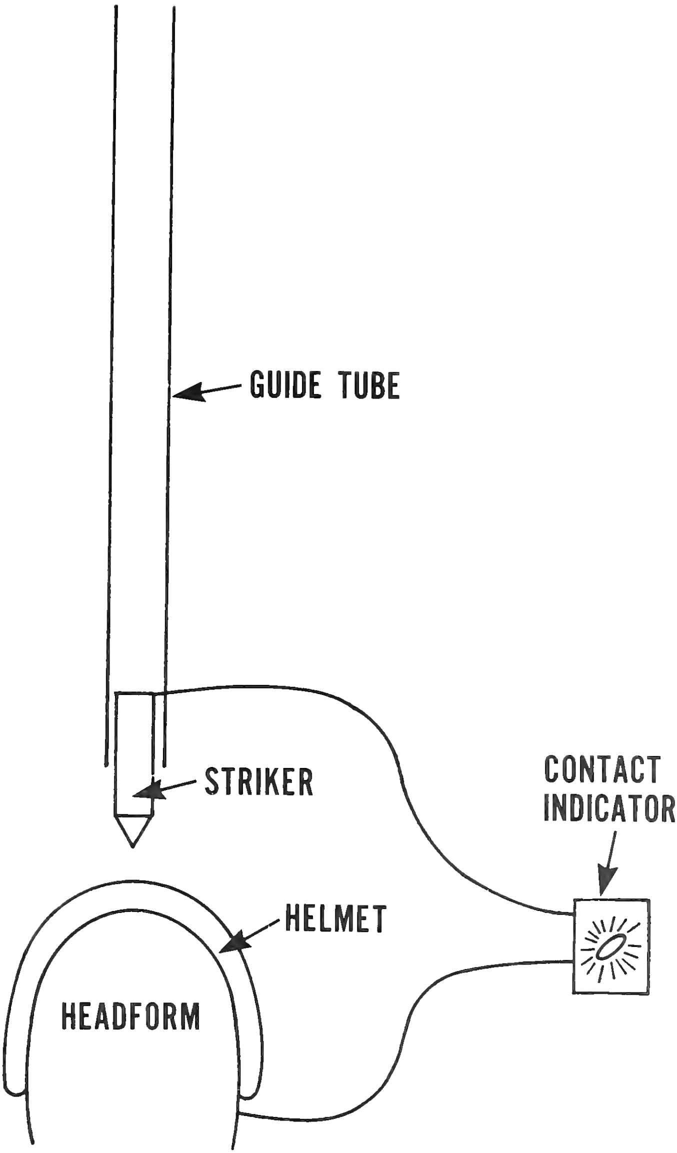


Figure 5. Penetration resistance test setup.

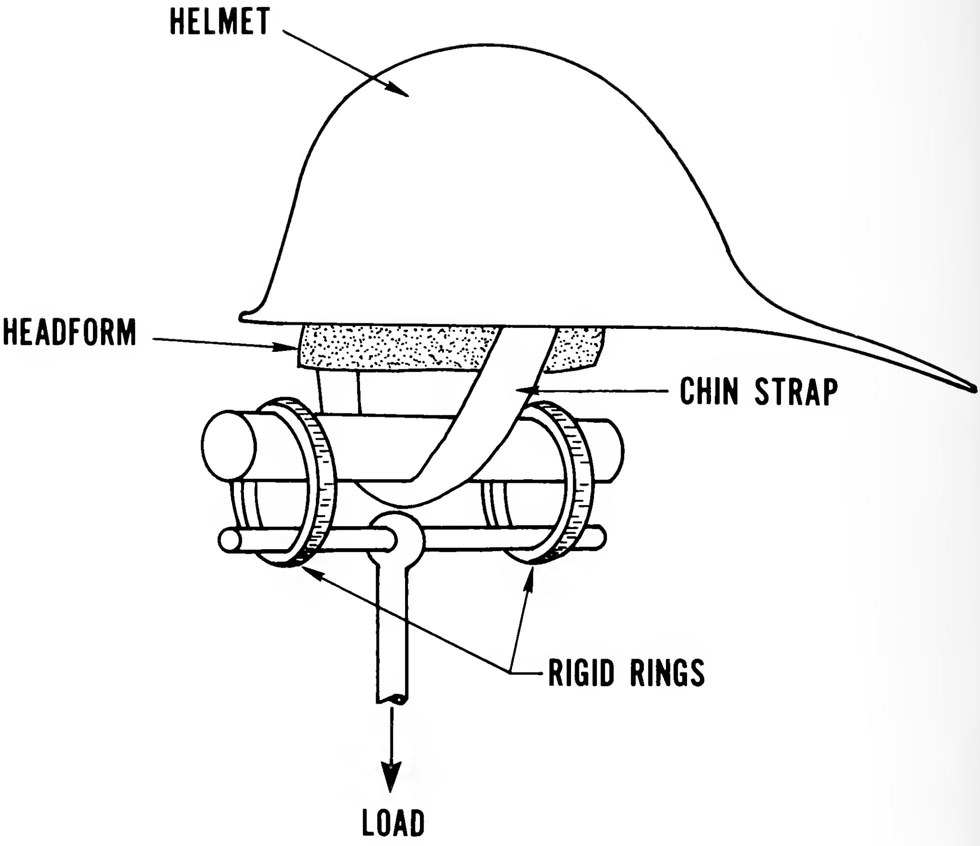


Figure 6. Chin strap/retention system test setup.

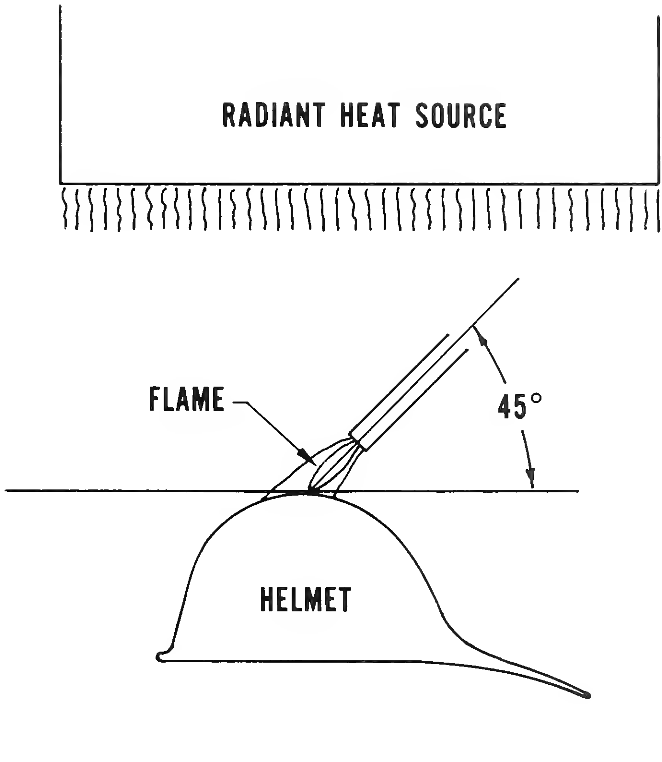


Figure 7. Flame resistance test setup.

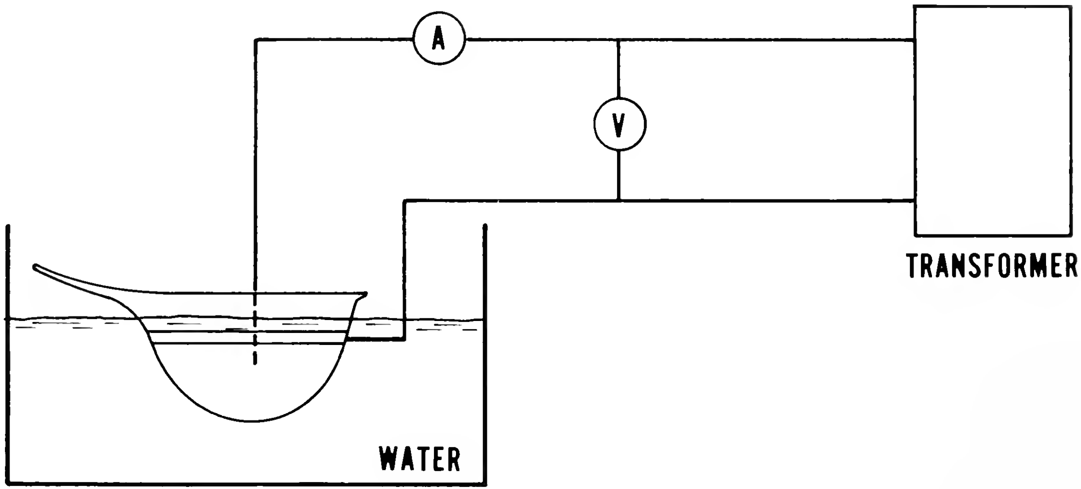


Figure 8. Electrical insulation test setup.